|Inside>

3D simulation that visualizes the execution of a quantum circuit on a quantum computer using Qiskit Pulse to an educational extent.

1. Motivation

Inside is about simulating and rendering the internal functioning of a quantum computer in a pedagogic manner to assist educating people regarding the engineering behind superconducting computer. Our project address the question of the internal workings of superconducting quantum computers and more particularly on the RF signals of the qubits controls.

2. Implementation

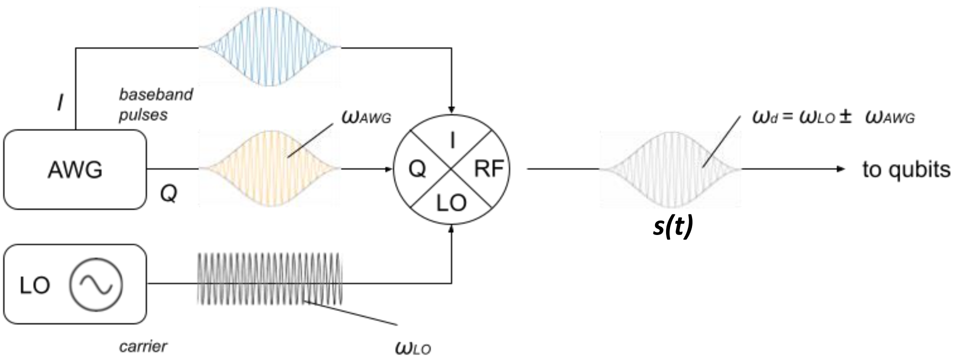
In order to link the 3D rendering with the Qiskit programs to be executed, we have coded a python function that generates a CSV file containing the pulse instruction data.

The "Pulse Data Extraction" function takes a schedule as argument and reads it to extract all the associated instructions. The data related to the instructions such as the bit on which the instruction acts, the shiftphase, the execution time of the instruction and the samples of the generated signals. All this data is then sorted and saved in a CSV file. It’s this CSV file that acts as the link between the Qiskit program and the 3D rendering on Unity.

AZI Yacine
CAMBIER Ulysse
SOUVIGNET Quentin

Superconducting quantum computers are based on transmon qubits which are assimilated to an anharmonic oscillator. These qubits are controlled by a capacitive microwave control line that allows single-qubit gates to be driven.

The control of these qubits is performed by IQ modulation in phase quadrature. The typical set-up for generating the control microwave signals is described below:



A low frequency generator with low phase noise is used to generate a sinusoidal pulse. In parallel to this, the two baseband signals, I and Q, are generated using an arbitrary waveform generator (AWG).

A 3-input 1-output mixer is used to perform the quadrature phase modulation. The I (Q) input of the IQ mixer will multiply the baseband signal to the in-phase (out-of-phase) component of the LO to generate an output signal s(t) characterised by the following relationship :

$$\boldsymbol{s(t) \ = \ I(t)\, cos(2\pi f_0 t \ + \ \varphi) \ + \ Q(t)\, sin(2\pi f_0 t \ + \ \varphi)}$$

I *is the "in-phase" component and* ***Q*** *is the "out-of-phase" component.*

3. Project results

Unfortunately, due to numerous problems and lack of time, we were not able to implement all features such as the display of measurement results.

4. Impact-outlook

Inside provides a representation and a way to understand in a more playful way how a superconducting quantum computer works. Our project is made to help people visualize ans understand how work a quantum computer and how quantum circuit are executed on them. This visualization allows to show theeffects of programming, on the hardware part of the computer.

AZI Yacine
CAMBIER Ulysse
SOUVIGNET Quentin